KSC annual report

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Introduction

This annual report presents the accomplishments of the preceding fiscal year in Research and Technology (R&T), and identifies current beneficial applications of previous R&T efforts.

Additional information concerning specific items relative to this report may be obtained from individuals referenced or from J. M. Spears, Chief, Special Projects Development Office, Code PT-SPD, John F. Kennedy Space Center 32899, phone 305-867-7705 or FTS 823-7705.

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Space Transportation System

The Space Transportation System (STS) mission brought about a variety of Kennedy Space Center (KSC) technological accomplishments during Fiscal Year 1981. The ongoing technology program in support of future missions yielded several new accomplishments. Following is a description of some of the more significant ones.

LAUNCH PROCESSING SYSTEM

Launch of the STS-1 on April 12, 1981 marked the first mission use of the Launch Processing System (LPS). The LPS is a high speed, digital, computer-operated checkout system used to support test, checkout, launch control, and operational management of launch site ground operations.

Firing Room 1 activities during countdown demonstration test.

Located in the Launch Control Center (LCC) in Firing Room 1, the LPS was responsible for most of the orbiter, tank, and booster checkout. Specific technology accomplishments that enabled successful implementation of the LPS concept include development of the Subsystem Operator Consoles, the Common Data Buffer (CDBFR), and the Ground Operations Aerospace Language (GOAL).

Subsystem Operator Consoles

Each subsystem operator position in a firing room has its own keyboard and visual display system. Each group of three keyboard and display systems is considered one "console," and operates as a unit. All consoles are orchestrated to work together on major tasks through an Integration Console at the front of the firing room. Each console can perform several tests or procedures simultaneously, the number possible dependent on its size. A small computer with each console has an on-line disk storage capacity of five million words, and can hold all test procedures to be conducted by its operator.

Checkout and launch functions of each console can be changed, if necessary, by patching and reloading data from the Master Console, or by physically moving disks from one console to another. This provides flexibility and redundant capacity. In addition, the independence of each console allows

Firing Room 1 is located in the Launch Control Center.

maximum parallel testing, thus saving serial time.

LPS monitors thousands of measurements on the vehicle and ground support equipment simultaneously, and compares them to predefined tolerance levels. It displays only values out of tolerance. This is termed "exception monitor capability." The monitor feeds outputs to console screens to display, in various colors, conditions that must be evaluated by the test engineer. In many cases these computers will automatically react to "exception" conditions and perform safing or other related functions without test engineer intervention.

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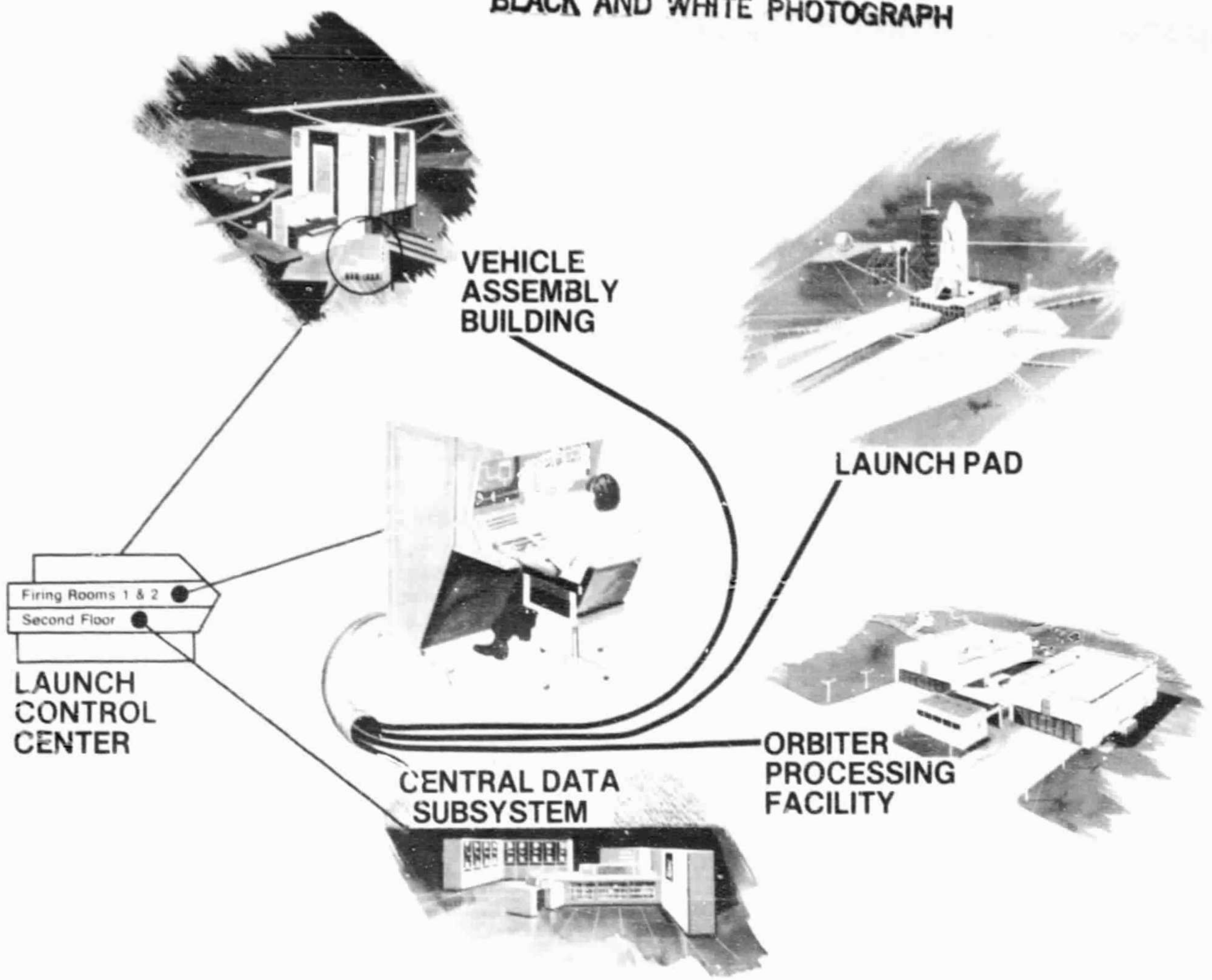


In operation, the Launch Processing System is central control point for most checkout, assembly, and launch activities for the Space Shuttle.

Common Data Buffer

Processing of information by the distributed network of computers is linked by a time-shared data buffer (memory) access. It is sequenced so that each of the computers in the network appears to be the only computer using the buffer. Developed as part of the 64-processor Checkout Control, and Monitoring System, the buffer temporarily stores data, messages, and commands along with error-correcting information. It assures proper retrieval of this information even when a portion of the buffer is inoperative as a result of failed hardware.

Ground Operations Aerospace Language

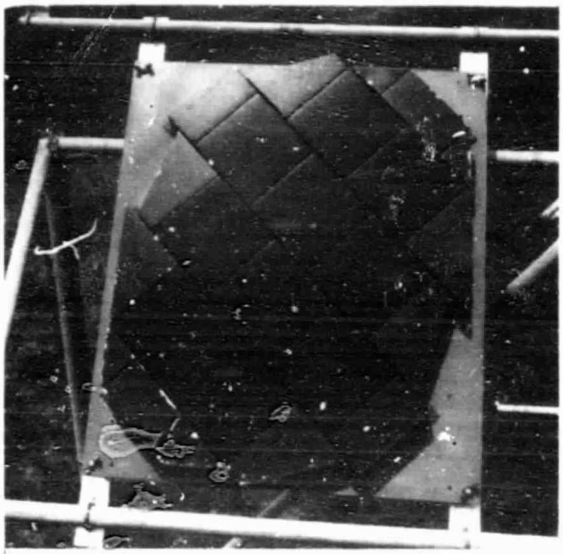
Applications programming of the Checkout, Control, and Monitoring computers used for the STS-1 mission was accomplished using a KSC developed high-order computer language, known as GOAL. This usage permits computer programs to be compiled from functional statements as they would appear in an English language test procedure. Test engineers can write and verify their own programs, permitting the test engineer to become adept at the use of the computer.

THERMAL PROTECTION SUBSYSTEM

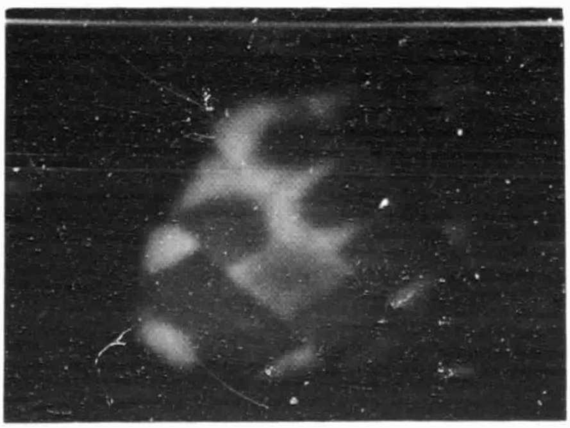
STS-1 orbiter Thermal Protection Subsystem (TPS) is designed to protect other orbiter subsystems from excessive heating during launch and during re-entry into Earth's atmosphere. Part of the TPS was initially installed on the orbiter during the manufacturing process. For STS-1, launch processing at KSC became an extension of TPS installation and of manufacturing and engineer-

ing development testing. TPS is regarded as the most critical subsystem to undergo extensive testing and iterative modification during launch processing.

KSC's technical accomplishments include recently developed infrared scanning techniques for detection of water or other contaminants that might be absorbed by damaged tiles.



High temperature reusable surface insulation TPS panel array undergoing waterproofing and environmental exposure tests at Launch Complex 39B.



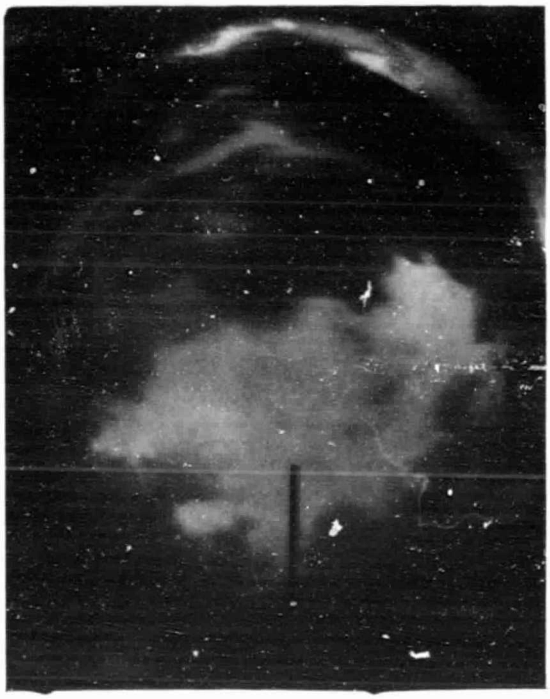
Infrared scan of the TPS array after being exposed to rain showers. Relative temperatures of the TPS tiles are depicted as shades of grey. In this view, areas which are light (warmer) contain moisture as opposed to the darker (cooler) tiles which are dry.

METEOROLOGICAL RESEARCH

Lightning research is continuing at KSC. Activities have been broadened to include weather prediction modeling. The total activity supports pre-launch, launch, and recovery operations at KSC and the Air Force Eastern Test Range.

Forecasts are provided by a round-the-clock team of Air Force meteorologists at the Cape Canaveral Air Force Station (CCAFS). Conventional weather radar is used, but the meteorologists also have several specialized tools at their disposal.

One is a Lightning Locator System which records cloud-to-ground lightning strikes. The system uses three antennas, located at KSC, Melbourne, and Orlando, to detect electromagnetic radiation from lightning strikes within a 200-mile radius. A computer in the Range Control Center (RCC) plots the strikes on a map, helping to pinpoint the location of active storms.



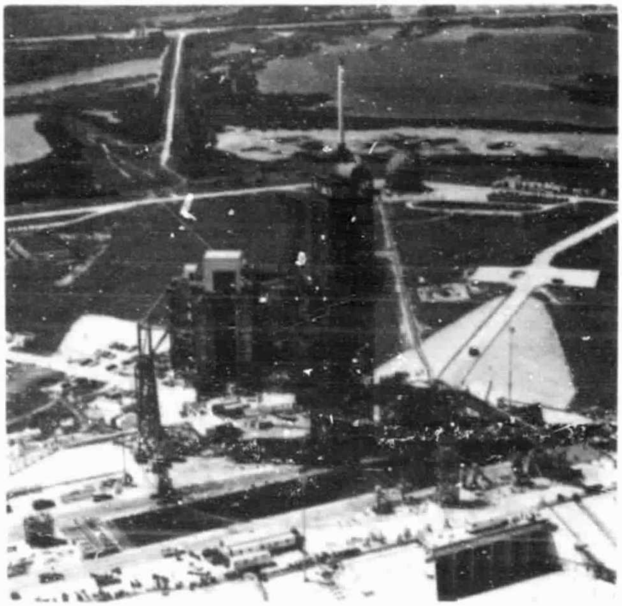
Lightning strikes the lightning mast on Pad 39A, as recorded by an All-Sky Camera under a waterproof bubble. The camera is triggered by electromagnetic radiation, and records all nearby strikes, not just those that hit the pad. The dark bar is a mark on the bubble to indicate north.

Another unusual tool, the Weather Information Network Display System (WINDS), helps to detect storms forming locally. Anemometers mounted on 14 towers scattered about KSC and CCAFS monitor surface winds throughout the area. A computer program is now under development to use this information to calculate wind convergence. Wind convergence (wind flow into an area) indicates air is being forced upward, a sign of storm development.

A third unique resource, the Ground Field Mill System, detects electric fields associated with approaching or developing storms, and indicates areas where conditions are favorable

for lightning strikes. Its instruments are located at 32 sites at KSC and CCAFS. Computer-generated maps show electrical field contours which resembles a topographical map.

The Shuttle will not be launched if electrical fields at the launch site exceed one kilovolt per meter or if its flight path will take it into dangerous weather. On the launch pad, the Shuttle is within the "cone of protection" of the lightning protection system. This system consists of a fiberglass mast with cable threaded through the top to grounding points 1,000 feet away on either side.

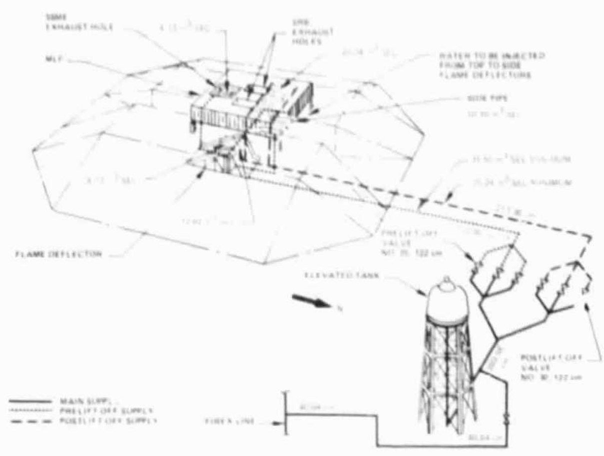


Aerial View – Complex 39A Payload Changeout Room and Launch Facility showing the fiberglass lightning mast.

SOUND SUPRESSION WATER SYSTEM

A sound suppression water system has been installed on the pad to protect the orbiter and payload from damage by acoustical energy reflected from the Mobile Launcher Platform (MLP) during launch. The orbiter and payload in the cargo hold, is much closer to the surface of the MLP than was the Apollo spacecraft at the top of a Saturn V or Saturn IB rocket.

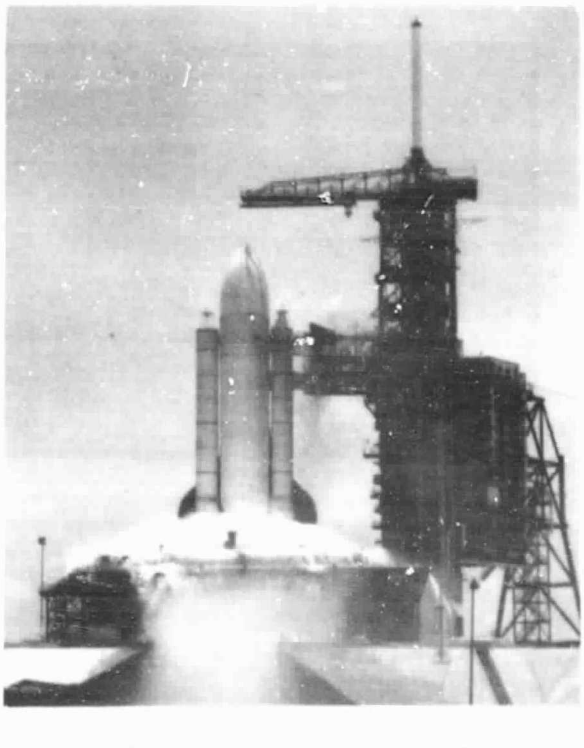
The system consists of an elevated tank, a valve complex, a piping system, and spray nozzles. The valve complex consists of six 122-centimeter (48-inch) butterfly valves to remotely control the water flow. Each valve is actuated by a piston-type, double cylinder, hydro/pneumatic actuator. To rapidly establish a minimum flow of 31.55 m^3/s (500,000 gpm) through the pre-liftoff system and



Sound Suppression systems at Launch Complex 39A, KSC.

25.24 m^3/s (400,000 gpm) through the post-liftoff system, at least two pre-liftoff and two post-liftoff valves must be fully opened within 4 seconds after receiving opening commands. The peak rate of flow from all sources is 3,406,500 liters (900,000 gallons) of water per minute at nine seconds after liftoff.

Acoustical levels reach their peak when the Space Shuttle is about 91 meters (300 feet) above the platform, and cease to be a problem at an altitude of about 308 meters (1,000 feet).

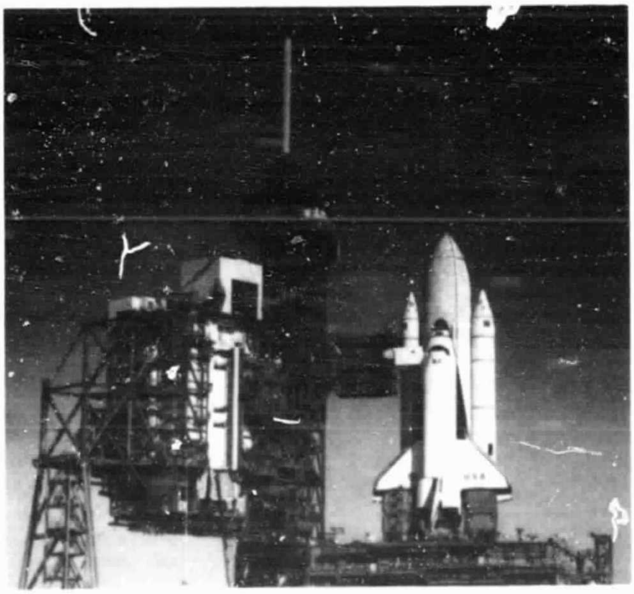


Space Shuttle water systems test-water flow in progress.

ROTATING SERVICE STRUCTURE

The Rotating Service Structure (RSS) provides access to the orbiter for installation and servicing of payloads at the pad. It pivots through one-third of a circle, from a retracted position well away from the Shuttle to the point where its payload changeout room doors meet and match the orbiter cargo bay doors. Most of its body is some 18 meters (59 feet) above the pad, supported by a hinge on the end attached to the Fixed Service Structure (FSS) and a structural framework on the opposite end. This framework rests on two eight-wheel motor-driven trucks, which ride on rails installed on the pad surface and spanning the flame trench. The rotating body is 31 meters (102 feet) long, 15 meters (50 feet) wide, and 40 meters (130 feet) high.

With the exception of the Spacelab and several other payloads which may be loaded while the orbiter is in the Orbiter Processing Facility (OPF), all spacecraft will be installed at the pad using the RSS.



Test configuration of the Space Shuttle on launch pad. Rotating Service Structure is at left; Fixed Service Structure in center connects vehicle with ground support equipment.

IMPROVED HYPERGOL VAPOR REMOVAL SYSTEM

Wet packed bed vapor scrubbers were developed and installed at KSC and used for the first time on STS-1, for removing hypergolic vapors being vented from hypergolic servicing equipment, propellant lines and space vehicle systems. The monomethylhydrazine (MMH) vapor scrubbers reduce gas from a toxicity level of 600 parts per million (ppm) to 3 ppm. The Nitrogen Tetroxide (N_2O_4) vapor scrubbers reduce gas from a toxicity level of 6,000 ppm to 30 ppm.

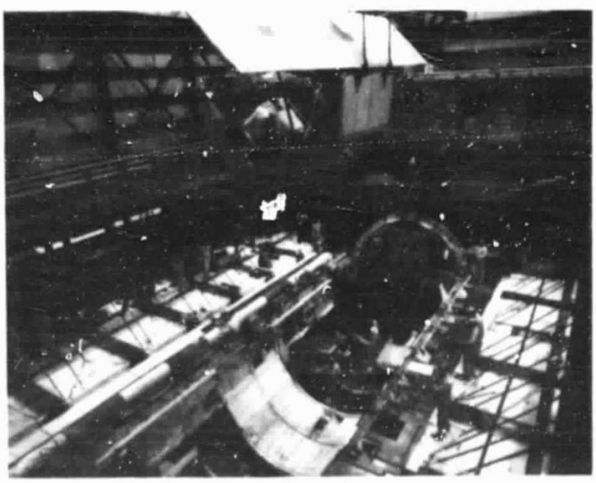
Based on increasing environmental restrictions, which at the present time require 25 percent greater dilution capability than we are achieving with our wet scrubbers, we are continuing research to develop an advanced scrubber system.

FIBER OPTICS RESEARCH

On-site installation and testing over a 22 km simulated run, of multimode fiber optic cable has been completed. Data gathered indicates attenuation of the cable will require use of repeaters with the multimode fibers. A test program of single mode fibers is underway to verify the lower attenuation specifications of the cable, connectors, and integrated optical components. This will determine if single mode fibers can be used without the use of repeaters. The single mode fiber communication system will handle high digital data rates, voice and television transmissions and other multiplexed signals to support present and future launch operations requirements.

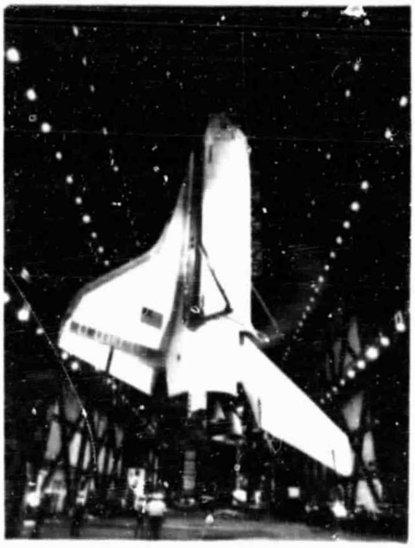
PRECISION POSITIONING

KSC has developed a variety of alignment and control devices and techniques for precise positioning of cumberson and easily damaged space hardware during vehicle assembly and handling as well

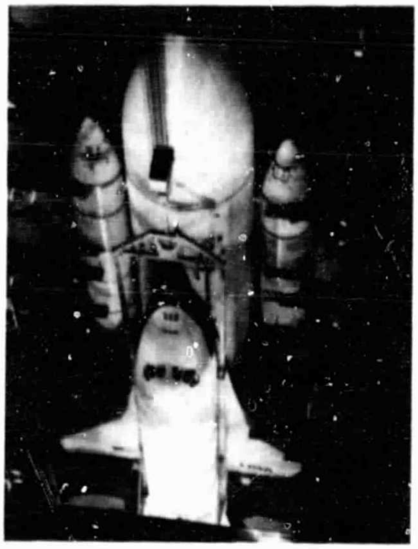


Office of Space and Terrestrial Application-1 installed in Orbiter Columbia's payload bay.

The solid rocket booster being stacked on the Mobile Launcher Plat⁻⁻rm. The external tank will next be mated to the boosters.



After being towed into the VAB, the orbiter is raised to the vertical position and lifted into the high bay by bridge crane for mating with the external tank.



The orbiter is lowered into position in the high bay to be attached to the external tank.

The orbiter in the Mate/Demate Device has just been lifted from the 747 carrier aircraft used in ferry operations.

as during payload integration operations. Alignment devices include those using optical, electronic, and laser technology.

Assembly of the Space Shuttle flight components takes place in High Bays 1 or 3 of the Vehicle Assembly Building (VAB).

The external tank rests on a trailer in the transfer aisle of the VAB after arriving at KSC by barge. A solid rocket booster segment can be seen in front of the VAB's translucent panels as it is moved into the high bays for stacking.

REMOTE CONTROLLED SOLID ROCKET BOOSTER NOZZLE PLUGS

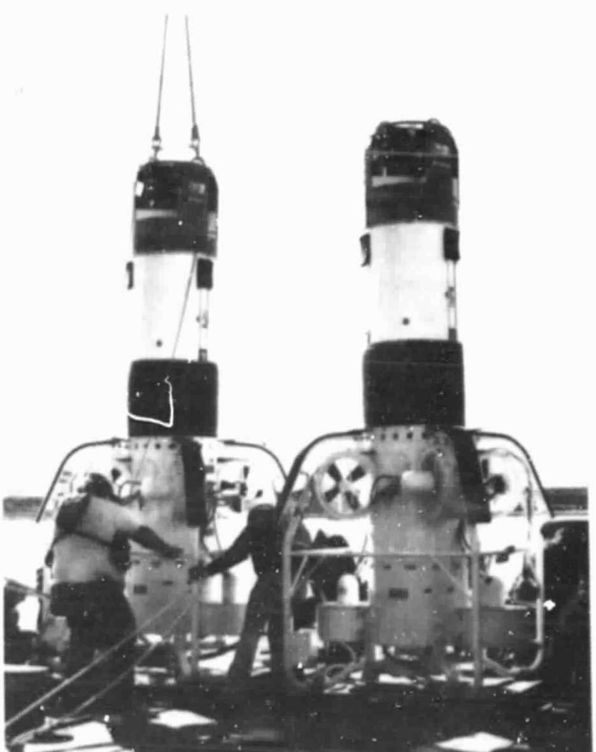
Remotely controlled nozzle plugs were developed for use in the recovery of the two spent solid rocket booster casings. The nozzle plug is 4.15 meters (14.5 feet) tall, 2.3 meters (7.5 feet) in diameter and weighs 1,590 kg (3,500 pounds). Remotely controlled it can move in any direction. It is powered by six hydraulically driven fan-type thruster motors. The four thrusters which give the plug its horizontal movement are positioned around the middle of the plug. The other two thrusters are located near the bottom and move the plug up and down. The thrusters propel the plug with a horizontal velocity of 0.9 meters (3 feet) per second a downward vertical velocity of 0.85 meters (2.8 feet) per second, and an upward vertical velocity of 1.4 meters (4.5 feet) per second.

After the plug is launched overboard, it is moved out to the bobbing Solid Rocket Booster (SRB) casing tethered by 183 meters (600 feet) of umbilical cable. Although it is possible to maneuver the plug at a distance of 122 to 137 meters (400 to 450 feet) from the ship, the practical operating range is between 30.5 to 91.5 meters (100 to 300 feet).

At the top of the plug is a video camera which allows the operator to view the position of the plug in relation to the casing, from a shipboard television monitor.

Once it is in position, the plug is lowered to a depth of about 44.2 meters (145 feet). As it descends, the television camera is used to inspect the SRB casing for damage incurred during launch, reentry or impact. Once it reaches the bottom of the SRB it is inserted and three 0.9 meter (3 feet) metal arms are extended, locking the plug into the SRB's rear throat.

Docking is verified by sensors on the plug's shock mitigation units, located just above the four horizontal thruster motors. Compressed air is then pumped into the water-filled cavity through the umbilical cord at a pressure of up to 5.27 kg per square cm (75 pounds per square inch). As the water is forced out, the SRB will begin its rotation from the vertical to the horizontal. When the water level recedes to a certain level, an inner tube-type bag is inflated to its full diameter of 1.42



Maneuvering tests with the nozzle plugs at Port Canaveral, Florida.

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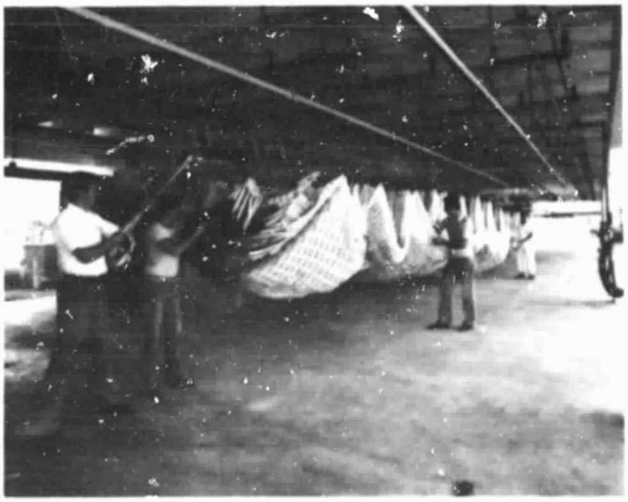
meters (56 inches), sealing off the same diameter hole in the bottom of the SRB. A 3 meter (10 feet) long dewatering hose is then deployed and the remaining water is forced out through it. It is then towed back to the KSC's SRB Disassembly Facility.

GROUND OPERATIONS FOR CENTAUR/ORBITAL TRANSFER VEHICLE

Ground support for an Orbital Transfer Vehicle (OTV), study was completed. The study considered current technology, facilities, and equipment at KSC and CCAFS. The Centaur upper stage was used as the representative candidate for a checkout and launch baseline. The study determined the most efficient and least costly means of loading cryogenic propellants and checking out and monitoring Centaur systems at KSC and CCAFS. The study provided baseline ground systems technology assessment data that supported the decision to use Centaur as an OTV.

PARACHUTE DRYING

The design of KSC's Parachute Facility is unique. In the past, large parachutes were hung in high bays and dried with forced air, which took two or more days. KSC's one-story facility accomplished the drying process in two hours, using smaller amounts of air and electricity.



KSC's one-story facility showing parachute being processed after drying.

The facility will refurbish both the drogue and main chutes. The drogue chute has a canopy 16.45 meters (54 feet) in diameter, and is 39.62 meters (130 feet) long with lines. The three main parachutes are each 70.1 meters (230 feet) long with lines, and weigh 1092 Kg (2400 pounds) each when wet.

STS HAZARDOUS WASTE DISPOSAL AND RECYCLE

The Solid Rocket Boosters use Marshall Spray Ablative (MSA) for thermal protection. The application process generates hazardous waste material consisting of solvent soaked products. Research to date has shown that 90 percent of the solvent can be removed after heating to 500 degrees Fahrenheit. Additional research is underway to determine recovery and disposal methods that will be environmentally acceptable and more cost effective than those currently in use for MSA waste materials.

TOXIC WASTE TECHNOLOGY AND CONTROL CONCEPTS

Research has shown there are several approaches to disposal of extremely dilute (less than 500 ppm) hypergolic solutions other than the burning or burying techniques currently in use. One such promising approach recently identified and being investigated further consists of using biological methods to reduce toxicity.

FAST ANALYTICAL DENSITOMETRY STUDY

Two of the major techniques used in the Microchemical Laboratory at KSC to identify materials are X-ray diffraction and emission spectrography, both require photographic media to record the pattern or spectrum. A new approach has been identified that may reduce or eliminate the need for visual reading of X-ray diffraction films. Currently, visual reading is necessary for more than 90 percent of all samples analyzed by diffraction and adds to the cost and time required. The primary expected benefit of the Fast Analytical Densitometry approach is a fast analysis turnaround time (two versus twelve hours) which will allow a major operation to proceed more quickly after a lab analysis.

SHUTTLE INVENTORY MANAGEMENT SYSTEM

A computerized Shuttle Inventory Management System (SIMS) was developed at KSC. SIMS I hardware consists of a Honeywell Information System (HIS) 66/60 computer with 512K words of memory. A DATANET 6632 is the communication controller used to transfer transaction data between more than 100 terminal devices and the HIS 66/60 computer. Within SIMS I, basic transactions (functions) including issues, requisitions, turn-ins, back orders, inventories, shipments, etc., are accomplished. The SIMS I software is designed to provide the capability for establishing and maintaining an array of files necessary for the performance of supply functions.

SIMS I major functions consist of Inventory Management, Materials Service Center Operation, Cataloging and Technical, and Management Information and ADP Products.

OPERATIONAL INTERCOMMUNICATIONS SYSTEM IMPROVEMENT

A conceptual design of a digital Operational Intercommunications System (OIS) with large scale conferencing capability has been completed. This design will enable KSC to replace several analog voice communication systems that have exceeded their design life expectancy. The digital system takes advantage of state of the art digital electronics and its inherent reliability.

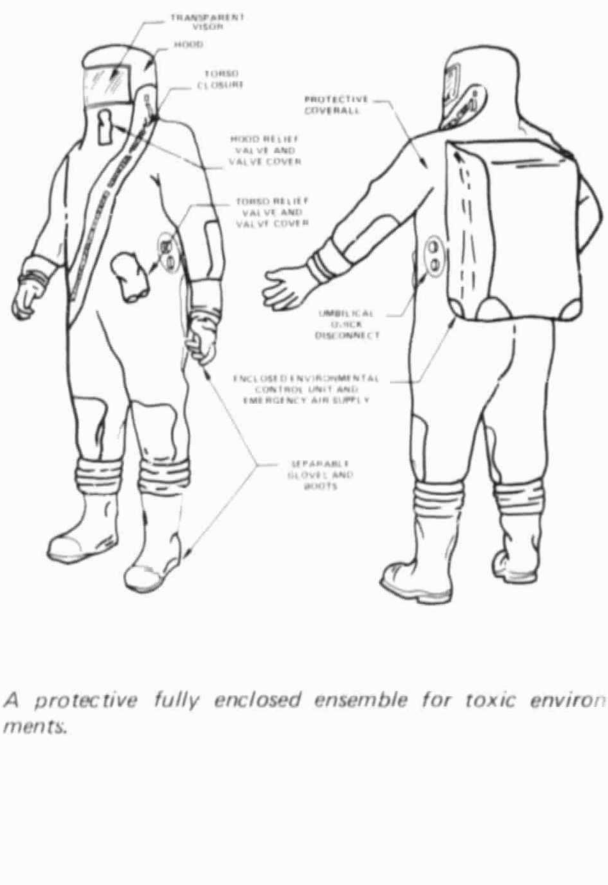
PROTECTIVE GARMENT ENSEMBLE

A protective ensemble being developed for toxic environments consists of a fully enclosed garment, complete with breathing air, air-conditioning and emergency air. It will be suitable for a 2 hour continuous mission. Toxic propellants at KSC are currently handled by an operator wearing a totally-enclosed protective garment. The garments in use at KSC were developed 20 years ago and require substantial physical exertion just to move to work stations; particularly in hot, humid weather.

In the new configuration, an environmental-control unit is attached to the user's back. In alternative modes, the unit is in a remote case and is hand-carried or a pressurized air line is used instead of the unit.

The environmental-control unit uses liquid air which is vaporized to provide breathing air and operator cooling.

The garment contains a flow-diverter valve that can be activated to isolate the environmental-control unit recirculation system and direct breathing air to the head area. The valve may be activated manually if the coverall becomes torn or is penetrated in a toxic environment. This provides the operator breathing protection during egress from a contaminated area.



A protective fully enclosed ensemble for toxic environments.

TERRESTRIAL APPLICATIONS

LANDSAT APPLICATION TO WATER RESOURCES

The severe drought experienced in Central Florida throughout most of 1981 brought increased attention to the long recognized problem of fresh water availability across the state. Much of the state's fresh water supply is obtained from natural lakes which are fed by regional and local rainfall. Many of these lakes reached record and near-record low levels during late summer of 1981 and forced the imposition of water rationing for individual households and municipal supplies as well as agricultural irrigation.

Management of water resources in Florida is the responsibility of Florida's five Water Management Districts. Especially during drought conditions, a close watch is maintained over all water supplies. This is most commonly done through monitoring of water stage, the water height above sea level. Although water stage is an important indicator, water storage volume is a more critical parameter. Volume can only be obtained if accurate data exists as to the lake contours in conjunction with water stage. Such data rarely exists because of the extensive time and cost associated with conventional transect survey methods of collecting such data and the fact that they are subject to change over extended periods of time.

KSC, in cooperation with the University of Florida and the St. Johns River Water Management District, developed a technique using Landsat data for estimating available water storage volume and applied it successfully to Lake Washington and Lake Harris in Central Florida. A number of Landsat scenes including the lakes of interest were selected to correspond with a wide range of lake stages as measured over the past nine years. Lake surface area was then measured from the Landsat data, and when properly averaged, was used with the change in lake level to estimate the change in lake volume. Thus the Water Management District can directly correlate changes in lake stage with available water volume. Tables 1 and 2 indicate the relationship of lake stage and water volume for Lake Washington and Lake Harris respectively.

Table 1. Lake Washington Volume Computation Based on the Water Surface Area Measured by Eight Dates of Landsat Data.

Date	Water Stage	Water Surface	Lake Volume Different Stages	0.01 Feet Increment
	---ft---	---Acre---	---Acre-feet---	
6/15/74	10.60	2,537	C*	26
4/11/76	11.81	2,670	C+3,150	27
2/9/76	12.06	2,683	C+3,819	27
3/17/74	12.45	2,705	C+4,870	27
2/27/74	12.75	2,729	C+5,687	28
9/6/72	14.80	2,819	C+11,372	28
11/29/73	14.84	2,827	C+11,485	28
10/19/74	15.85	2,850	C+14,352	

*C is a constant volume below the stage of 10.60 feet.

Table 2. Lake Harris Volume Computation Based on the Water Surface Area Measured by Four Dates of Landsat Data.

Date	Water Stage	Water Surface	Lake Volume Different Stages	0.01 Feet Increment
	---ft---	---Acre---	---Acre-feet---	
9/6/72	62.38	17,430	C*	176
8/31/72	62.50	17,724	C+2,109	178
2/14/75	62.66	17,963	C+4,964	183
1/22/76	63.30	18,657	C+16,682	

*C is a constant volume below the stage of 62.38 feet.

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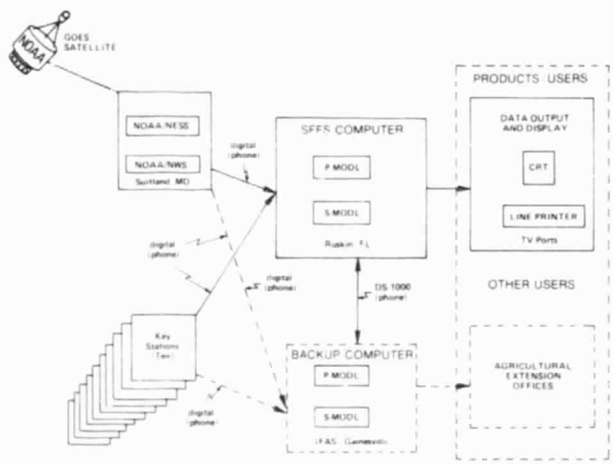
SATELLITE FREEZE FORECAST SYSTEM

Because of its temperate climate, Florida is a major producer of agricultural crops subject to cold weather damage. Among the foremost of these is citrus, which represents about 1/3 of Florida's agricultural production. It is the responsibility of the National Weather Service (NWS) to alert growers when cold weather is likely to pose a hazard to their crops. This occurs about twelve times each year.

Under the technology applications and transfer program, National Aeronautics and Space Administration (NASA) at KSC has sponsored and cooperated in the development of a system for monitoring and predicting temperatures based on data from the Geosynchronous Operational Environmental Satellite. This development was led by scientists at the Institute of Food and Agricultural Sciences at the University of Florida in Gainesville, Florida, and was supported by NASA at KSC and the National Oceanic and Atmospheric Administration (NOAA).

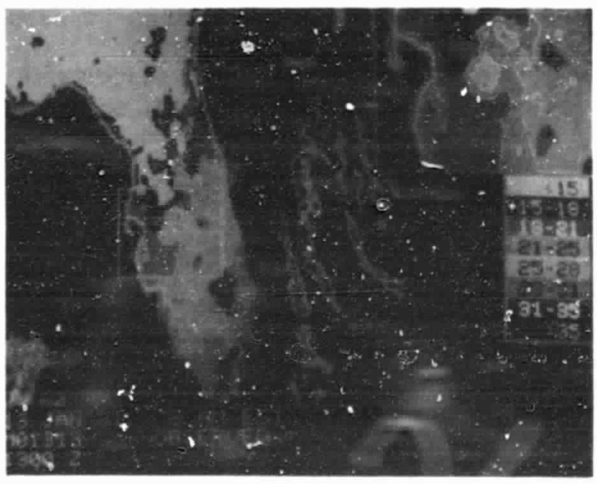


Schematic diagram of the Satellite Freeze Forecast System.

The Satellite Freeze Forecast System, central computer located at Ruskin, Florida, interrogates the satellite and receives the latest hourly temperature distribution of the Florida peninsula in digital data form. It then interrogates the ten ground stations placed throughout the state and receives the appropriate meteorological data. After three consecutive hourly readings these data are entered into a mathematical model which forecasts the temperatures at each key station throughout the remainder of the night. These key station

Satellite Freeze Forecast System as installed in National Weather Service Station in Ruskin, Florida.

forecasts then are entered into a second mathematical model. This uses correlation coefficients based on historical data of past freezes to extrapolate the key station forecasts to produce a predicted temperature distribution for the entire state for the remainder of the night. This entire sequence is completed automatically by the computer. The information is presented to the forecaster on a color Cathode Ray Tube display and may be printed in hard copy on a line printer. The forecaster has many options available for data display, including observed satellite temperature map, forecast temperature map (in the same format as observed), or historical maps of past freezes or past observations. He can select an area for enlargement, or can show any two maps simul-



Cathode Ray Tube Display.

taneously. This information is used by the forecaster along with conventional data in preparing, modifying, and disseminating his forecast. In addition to conventional information dissemination channels, this data can be made available to commercial television stations.

The primary operational system development, test, evaluation, and demonstration was completed in 1981 and the system is ready for operation during the upcoming 1981-1982 winter season.

APPLICATION OF GROUND PENETRATING RADAR TO SOIL SURVEY

A variety of manual and mechanical augers and probes are usually the basic tools used in examing soils for making soil surveys and investigating hydrologic and geotechnical characteristics close to the ground surface. The number of observations is limited by time and money. They are spaced to best define the area being surveyed and are based on the soil scientist's understanding of soil formation, vegetation, natural drainage, topography, and other features in the landscape. This work is highly labor-intensive and relatively slow; additionally, the quality of the results is a function of the variability of the area being mapped. To improve the definition of a complex area, a greater number of observations is required per unit area. In these circumstances time limitations and costs may become unreasonable or prohibitive. Remote sensing techniques, primarily various types of airborne imagery, have proved to be a valuable tool for determining soil boundaries. However, imagery detects properties of the soil surface and various kinds of vegetation. While these are helpful, most properties that are of primary significance to the classification, mapping, and interpretation of soils are beneath the surface.

To circumvent the limitations of tools and imagery, other options such as sonar, geophysical sounding devices, and gravity techniques were investigated as part of a cooperative project between the Soil Conservation Service (SCS) and NASA at KSC. Of all options evaluated, Ground Penetrating Radar (GPR) appeared to have the greatest potential for use in the soil survey. This new geophysical method permits, by way of surface sensor, continuous real-time observation and recording of some soil properties below the ground surface. The system used in this work was the Geophysical Survey Systems, Inc. (GSSI) impulse radar, the only system commercially available at the time of the study. The GSSI unit is an impulse radar system which radiates repetitive electromagnetic pulses at optional frequencies of 80 to 1000 megahertz per second (MH_z) into the earth from an antenna coupled to the ground surface.

As a result of the joint SCS and NASA investigation, SCS has recently purchased a GPR instrument and is in the process of developing procedures for using GPR in operational soil surveys.

TURTLE TRACKING

KSC has developed a system for the National Marine and Fisheries Service (NMFS)/NOAA to track sea turtles whether they are submerged or floating on the surface. The highly automated system uses a radio frequency spectrum analyzer and a microprocessor to process the data and provides a printed record. A large number of transmitters, each transmitting on different frequencies, can be monitored simultaneously.

EVALUATING COMPUTER-DRAWN GROUND COVER MAPS

Computer-generated character maps from Landsat data were compared to aerial photos (and actual ground cover) for two test sites in Florida. The test sites were each about 20 miles (32 km) square. One was characterized by hardwood forests, softwood forests, grazing lands, cultivated fields, rivers, lakes, small towns, and scattered residential areas. The other had similar features, plus part of a city and some mining areas.

Two techniques for analyzing data from the Landsat satellite were evaluated. The techniques consisted of an unsupervised (i.e., operated without human interference) clustering algorithm, called Landsat Signature Development Program (LSDP), and an interactive algorithm based on the multispectral image analyzer (Image 100) at KSC. LSDP computer maps and Image 100 plots were produced at a scale of 1:24,000 (the scale of US Geological Survey maps). The most promising computer maps for both test sites were compared to geological survey maps and to aerial photos. In making comparisons, attention was given to determining whether the computer-generated maps could depict characteristic ground features.

The exact location of such specific ground features as small residential areas, roads, small rivers, and lakes could not be determined from any of the evaluated computer-generated maps in the study. Due to edge effects, such features were classified in one of the surrounding-cover catagories. The study also found that the smaller the number of classifications used, the easier the maps were to interpret and the higher the accuracy of the maps.

It was concluded that, overall, Landsat-generated maps are satisfactory depictions of actual ground conditions and that computer classification of digital Landsat multispectral data, supplemented with certain ground-cover information, may be a valuable tool, in the hands of qualified scientists, for the analysis of renewable resources.

SPARKLESS LOAD PULSER

A widely used technique for identifying which circuit breaker controls a particular line is to pulse the current—for example, by turning a lamp on and off—and then to use a "clip-on" current meter to find out which line carries the pulsating current. This permits identifying the circuit breaker without interrupting power.

The pulsating current is conventionally produced by a load pulser, which consists of a cam-operated switch that repeatedly connects and disconnects a resistor across the line or receptacle. Unfortunately, the switch generates sparks at the contacts and therefore is not safe in hazardous environments (such as areas where combustible gases or vapors may be present).

To avoid the spark danger, a new electronic load pulser using a silicon-controlled rectifier (SCR) driven by a timer was devised to open and close the connection to a power resistor. The entire assembly of SCR, timer, direct-current (dc) supply for the timer, and resistor is mounted in a compact housing; it is simply plugged into the outlet for which the circuit breaker is to be identified and can be used to verify 110/120 volt or 208 volt receptacles. If a stepdown transformer is added, 480 volt circuits may also be checked.

COUPLING A MICROCOMPUTER AND COMPUTING INTEGRATOR WITH A GAS CHROMATOGRAPH

The objective was to develop a convenient method for storing and comparing information from the pyrolysis chromatograms of bacteria. Traditionally, chromatograms recorded on chart paper (12 inches x 6-8 feet) were compared manually to search for similarities and differences. Reproducible differences have been used to confirm the identity of microbes relative to those present in the local catalog of reference microbes. Such methods are subject to individual bias introduced by the person performing the comparisons, and such methods are not easy to subject to rigorous statistical analysis. When computing integrators and microcomputers became available in 1974-1976, it was apparent that such instrumentation, when interfaced with Pyrolysis Gas-Liquid Chromatographs, could alleviate much of the manual effort required for identification of samples.

The advantage of this system is that it is now relatively easy to obtain a chromatogram and store data (peak areas and retention times) in a computer. This stored data can be examined using a software package to perform identifications of microbes. Since the raw data is permanently saved on disks it could be examined using a radically different interpretative approach. The data analysis capabilities are limited only by the capacity and power of the microcomputer, and the imagination of the programmer.

References

ITEM	RESPONSIBLE INDIVIDUAL	PARTICIPATING ORGANIZATION	NASA HEADQUARTERS SPONSOR
Launch Processing System	W. Bailey, 867-3865, Design Engineering	General Electric Planning Research Corporation International Business Machines	OSTS
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Turtle Tracking	C. L. Lennon, 867-4068, Technical Support	National Marine & Fisheries Services NOAA	OSTA
Computer-Drawn Maps	U. Reed Barnett, 867-3017, Special Projects	University of Florida	OSTA

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